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Hyperbaric Oxygen Therapy for Muscular Dystrophy

by

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In 1966 Ashmore and Somes[1] observed that oxyged therapy may either alleviate or retard the symptoms of hereditary muscular dystrophy of chicken. Moreover, they showed some improvement of the histological and histochemical findings of the affected muscles[2][3]. On the basis of the results of their experiments, hyperbaric oxygen therapy was tried on patients with muscular dystrophy, resulting in functional improvement.

Materials and Treatment

Ten patients with muscular dystophy were treated with the hyperbaric oxygen therapy as shown in Table 1. Five cases were classified as Duchenne type and five as limb-girdle type, ranged from eight to thirty-three years old. One case of limb-girdle type (Case 8) was complicated with Raynaud's syndrome which was treated by bilateral lumbosacral sympathectomy before hyperbaric oxygen therapy. The stages of the disease were classified according to Swinyard's criteria[4].

The patients were subjected to hyperbaric oxygen chamber (HOC) at a pressure of 15 psig (2 absolute atmospheres of pressure). The patients inhaled 100% oxygen gas through a face mask, in combination with intravenous infusion of the following agents : fructose, ATP, CDP-choline, reduced glutathione and sodium carbazochrome sulfanate. In addition, the patients were orally given essential amino acids. Further, Case 6 was intramuscularly given nandrolone phenylproprionate.

The therapy was carried out once a day for one hour, summing up to 19 hours in three weeks. In Case 8 the therapy was done twice as long as usual period with 10 days intermission.

The effects of this treatment were evaluated by patient's estimation, ADL and physical examination, such as range of motion, muscular power measured by manual testing and spring scale, standing time on one leg, breath holding time and rapidness of walk. During the therapy, laboratory examinations including serum GOT, GPT, ALD, LDH, CPK, urinary creatine and creatinine and venous Po_2, Pco_2, and pH were

Table I Patients Treated with Hyperbaric Oxygen

Case No.	Sex	Age (yrs.)	Type & Stage	LeGends for Figures
1	M	8	Duchenne-3	△——△
2	M	10	Duchenne-3	▲——▲
3	F	11	Duchenne-4	▲- - -▲
4	M	11	Duchenne-5	●· · ·●
5	M	10	Duchenne-5	●- - -●
6	M	16	Limb-Girdle-2	×— —×
7	F	20	Limb-Girdle-2	×- - -×
8	M	33	Limb-Girdle-2	○——○
9	M	15	Limb-Girdle-3	○- - -○
10	M	19	Limb-Girdle-3	△· · · ·△

carried out regularly one or two times a week.

Results

Activities of daily living (ADL)such as bed positioning (Cases 4 and 10), walking (Cases 3, 6 and 8) and going up and down stairs (Cases 6 and 8) were performed

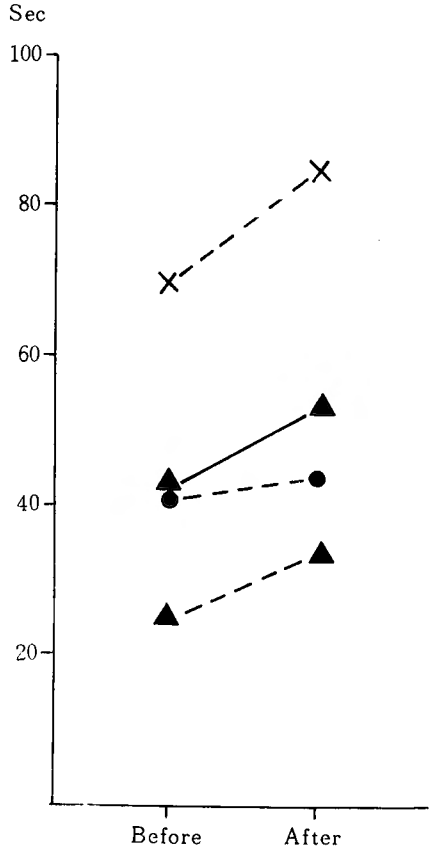

Fig 1 Breath Holding Time

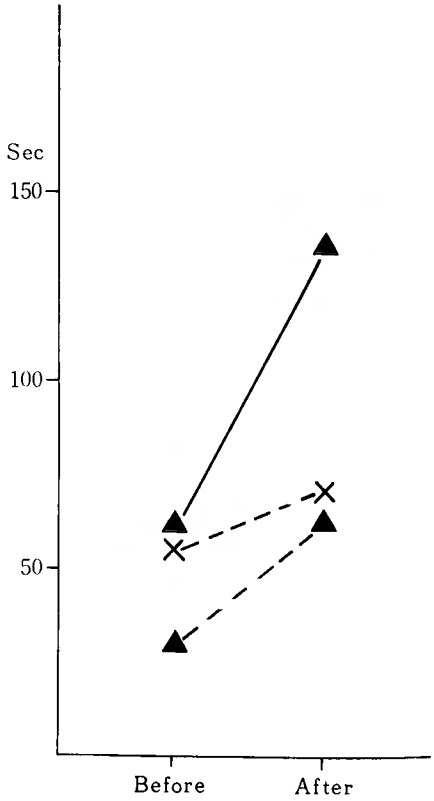

Fig 2 One Leg Standing Time

more actively after treatments than before. The manual muscular testings carried out before and after the therapy revealed an increase in the muscle power of girdle and trunk muscles.

Figs. 1 and 2 depicted the changes in breath holding time in four patients (Case 2, 3, 5 and 7) and in left leg standing time in three patients (Cases 2, 3 and 7). The grip power and back muscle stretching power during and after the therapy were shown in Figs. 3 and 4, respectively. These findings indicate more or less improvement of muscle power by the hyperbaric oxygen therapy. Furthermore, the definite shortening of time consumed for walk in a certain distance were recognized in Cases 3, 8 and 9.

No particular changes in blood cells, blood chemistry and creatine and creatinine in urine were found, changes in CPK being shown in Fig. 5.

Venous Po_2 usually imcreased immediately after the therapy, Pco_2 showing no remakable changes (Table II).

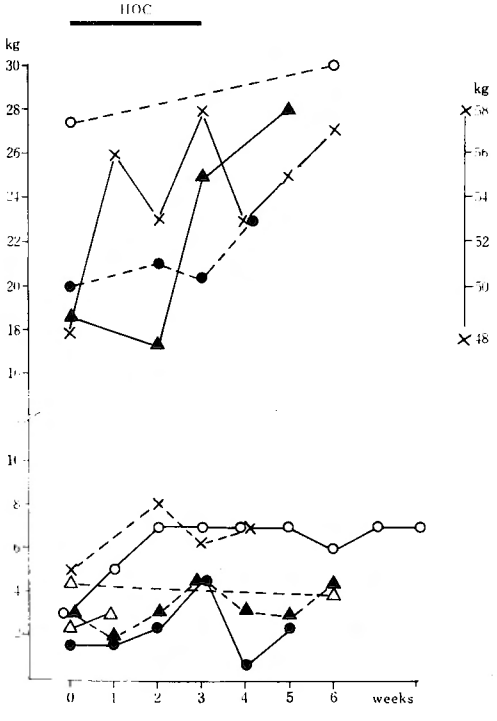

Fig 3 Grip Power

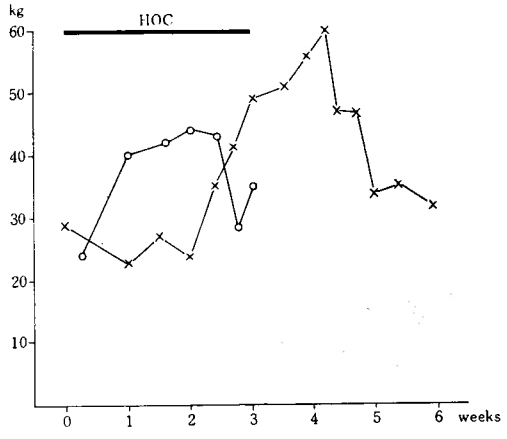

Fig 4 Back Muscle Stretching Power

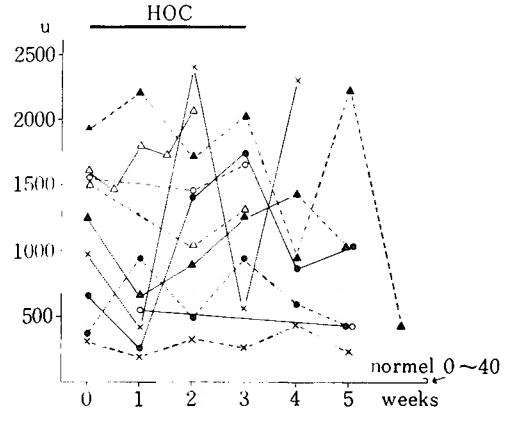

Fig 5 CPK (Creatine Phosphokinase)

Table Ⅱ Changes in Venous Po_2, Pco_2 and pH* Before and Immediately After One Hyperbaric Oxygen Treatment

Case No.		Po_2 Before After	Pco_2 Before After	pH Before After
1	Ⅰ**	48→ 80	41→ 37	7.48 → 7.48
	Ⅱ	58→ 44	32→ 32	7.46 → 7.50
	Ⅲ	46→ 41	46→ 38	7.40 → 7.41
	Ⅳ	120→ 66	42→ 41	7.42 → 7.46
2	Ⅰ	74→ 7.4	45→ 41	7.45 → 7.47
	Ⅱ	50→ 59	40→ 36	7.43 → 7.46
	Ⅲ	42→130	40→ 39	7.41 → 7.43
	Ⅳ	51→ 68	48→ 44	7.40 → 7.44
3	Ⅰ			
	Ⅱ	32→ 34	35→ 52	7.39 → 7.38
	Ⅲ	42→ 48	34→30.5	
	Ⅳ	35→420	40→ 31	
4	Ⅰ	17→ 45	16 →15.5	
	Ⅱ	40→ 64	28 →27	7.46 → 7.39
	Ⅲ	27→ 64	30.5→ 31	
	Ⅳ	30→102	35 →38	
5	Ⅰ			
	Ⅱ	42→580	33 →26	7.48 → 7.47
	Ⅲ	30→ 70	34 →27	
	Ⅳ	21.8→36.5	36 →32	7.48 → 7.48
6	Ⅰ	28→ 93	14→115	
	Ⅱ	39→100	37→ 35	
	Ⅲ	37→330	30→ 90	
	Ⅳ	35→470	48→ 35	
7	Ⅰ			
	Ⅱ	27→ 60	30→ 32.5	7.50 → 7.46
	Ⅲ	22→ 46	33→ 34	
	Ⅳ	17→ 50	36→ 29.5	7.51 → 7.53
8	Ⅰ	46→103	46→ 33	7.43 → 7.46
	Ⅱ	50→ 50	46→ 41	7.43 → 7.49
	Ⅲ	51→ 47	42→ 38	7.44 → 7.46
	Ⅳ	34→ 26	45→ 49	7.44 → 7.44
10	Ⅰ	37→ 42	44→ 33	7.44 → 7.46
	Ⅱ	36→ 43	44→ 44.5	7.45 → 7.50
	Ⅲ	50→ 39	37→ 26	7.39 → 7.45

* Normal value : $Po_2$40mmHg ; $Pco_2$35mmHg

** Ⅰ : 1st ; Ⅱ : 7th, Ⅲ : 13th and Ⅳ : 19th (last) therapy

No side-effects were encountered in all cases except for Case 6 who complained of mild fatigue one week after the start of therapy.

Discussion

The cause of muscular dystrophy has not yet been elucidated, but the theory of "abnormal permeability of the cell membrane" is most extensively supported.

Shapira et al[5]. demonstrated circulatory disturbances and a diminution in oxygen consumption of dystrophic muscle. Ashmore and Somes[1] reported that hypoxic state was first developedin the white muscle which was to be affected at an early stage of the disease. On the other hand, Ackerman and Brinkley[6] proved that administration of 100% oxygen at 15 psig caused an immediate increase in tissue Po_2. One of the effects of the hyperbaric oxygen therapy, therfore, is thought to improve anoxic state in the muscles of dystrophic patients.

It is thought that proper hyperbaric oxygenation may activate the P-bound-enzymes in the cell cytoplasma[7]. Therefore, this therapy might affect the glycogenolysis and the Lohmann's reaction in the muscle. CDP-choline, a co-enzyme essential for the biosynthesis of lecithin, was administered in combination with ATP, expecting a favorable effect upon the metabolism of lecithin which was said to be disturbed in muscular dystrophy[8].

For control, three patients of Duchenne type were subjected to the hyperbaric oxygen therapy without infusion of the agents mentioned above or the oxygen therapy at normal pressure (0 psig). No appreciable objective effects were observed, though there seemed to be some improvement of subjective symptoms. Therefore, it is assumed that the agents administered intravenously at high pressure, especially, ATP and CDP-choline exerted a favorable effect on the metabolic system in the muscles.

The results obtained disclose the favorable effect of hyperbaric oxygen on affected muscles in the dystrophic patients, particularly in cases being in earlier stage of both types. However, this effect seems to be apparent only during the period of treatments. The follow-up study carried out five years later reveals that the progression of muscle weakness in no patients is alleviated or prevented by this therapy. In order to applicate the hyperbaric oxygen more effectively on patients with muscular dystrophy, further investigations are required not only on the metabolism of dystrophic muscle, but on such points as selection of type and stage of the disease, duration of the therapy and choice of drugs.

Conclusion and Summary

On the basis of the experiments that oxygen therapy alleviated the symptoms of

hereditary muscle dystrophy in the chicken or prevented its progress, the authors carried out the hyperbaric oxygenation on ten patients with muscular dystrophy for three weeks.

Inhalation of 100% oxygen at a pressure of 15 psig combined with intravenous administration of ATP and CDP-choline gave a marked improvement of muscle strength, resulting in an increase of grasping power, back stretching power, a prolongation of standing time on one leg, breath holding time, and an increased rapidness at walk. However, no convincing labolatory data were available for attesting its efficacy.

Though hyperberbaric oxygenation with ATP and CDP-choline may be effective for muscular dystrophy, a number of problems yet remains to be solved.

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和文抄録

進行性筋ジストロフィー症に対する高圧酵素療法

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久　山　　健

10例の進行性筋ジストロフィー症患者（うち5例はDuchenne型，残りは肢帯型）に対して高圧酸素療法を行ない，少なくともその治療期間中は良好な成績を得た．

即ち 15 psig（絶対2気圧）の圧の下の高圧酸素室内で，マスクから100％酸素を吸入せしめると共にATPおよび CDP-choline の点滴静注を行った．治療期間は週5回で3週間であったが，その前後に自覚症状，歩容，階段昇降の難易などを観察すると共に，吸気停止時間，片脚起立時間，一定の距離の歩行時間，握力，背筋力などを測定した．また血中 GOT, GPT, ALD, LDH, CPK, 尿中creatine, creatinine量および静脈血中 Po_2, Pco_2, pH なども測定した．

治療期間中は全症例に何らかの ADL 改善，筋力増加が認められたが，血液，尿所見に著変を見なかった．なお Po_2は治療直後は明らかに上昇した．

高圧酸素療法後5年を経て追跡調査を行ったが，本療法によって本症の病勢進行を遅らせることは出来なかった．なお本法実施中副作用を見たものはない．

進行性筋ジストロフィー症に対する適確な治療法のない今日，高圧酸素療法の応用は今後研究されるべき分野の1つであろう．